PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Commissioner
US Department of Commerce
United States Patent and Trademark Office, PCT
2011 South Clark Place Room CP2/5C24
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing:	
18 January 2001 (18.01.01)	
International application No.: PCT/PL00/00030	Applicant's or agent's file reference:
International filing date: 19 April 2000 (19.04.00)	Priority date: 12 July 1999 (12.07.99)
Applicant: OLĘDZKI, Wies&Istrok;aw, Julian	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International preliminary Examining Authority on:

02 October 2000 (02.10.00)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer:

J. Zahra

Telephone No.: (41-22) 338.83.38

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

8

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
./.		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/PL00/00030	19/04/2000	12/07/1999

International Patent Classification (IPC) or national classification and IPC
B60G17/02

Applicant
OLEDZKI, Wieslaw, Julian

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 4 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☒ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
02/10/2000	09.10.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Roberts, D Telephone No. +49 89 2399 8880

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/PL00/00030

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
Description, pages:

3-9	as originally filed			
1,2	as received on	18/09/2001	with letter of	10/09/2001

Claims, No.:

1-9	as received on	18/09/2001	with letter of	10/09/2001

Drawings, sheets:

1/8-8/8	as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   - ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
   - ☐ the language of publication of the international application (under Rule 48.3(b)).
   - ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   - ☐ contained in the international application in written form.
   - ☐ filed together with the international application in computer readable form.
   - ☐ furnished subsequently to this Authority in written form.
   - ☐ furnished subsequently to this Authority in computer readable form.
   - ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
   - ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-9
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-9
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-9
	No:	Claims	

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

1. Reasoned Statement (V)

1.1 The present invention relates to a vehicle suspension system comprising a spring and a four-link mechanism and having a non-linear dependence of deformation of the spring on the vehicle wheel movement. Such a system corresponding to the preamble of claim 1 is known, for example, from WO-A-96/11815.

1.2 The object of the present invention to provide an improved suspension system having a compact, simple and robust structure able to cope with large loads.

1.3 The above object is achieved by means of the characterising features of claim 1, which are neither known from nor rendered obvious by the available prior art.

2. Certain Defects (VII)

2.1 The application contains the following obvious error (see Guidelines VI-7.14): The word "sliders" is missing in claim 9, line 4 between "corresponding" and "(D1)".

Vehicle suspension system, particularly for road and off-road vehicles

The present invention relates to a vehicle suspension system, particularly for road and off-road vehicles, such as trucks, buses and military vehicles, including tanks, and first of all for those vehicles whose weight and dynamical loads vary within a broad range during the operating process.

The main function of vehicle suspension is to reduce vibrations transferred to a vehicle body by vehicle wheels. The suspension is a set of elements connecting the vehicle wheels with the vehicle frame or body. Suspensions of automotive vehicles are fitted with steel springs such as leaf springs, coil springs, torsion bars, as well as solid rubber elements and pneumatic springs and hydro-pneumatic elements.

Leaf springs are made of elastic steel flat bars. The leaf spring, supported in the middle and loaded on both ends, is subject to deformation and simultaneously works against the forces of elasticity.

Coil springs are made of steel spring wire. They are lighter and easier to assemble than leaf springs but unable to transfer side forces, hence additional elements are necessary to hold the vehicle axle.

Torsion bars are steel springs made in the form of rod, tube or flat bar pack, one end of which is anchored e.g. in a vehicle frame while the other one is twisted by an arm of a vehicle wheel.

Pneumatic springs are built in the form of two or three-fold bellow manufactured of synthetic rubber reinforced with cord plait and tightened in metallic holders. Pneumatic springs work utilizing pressure of compressed air contained therein. They are used in buses and trucks as well as in off road vehicles. There are also hydro-pneumatic suspensions, in which the elastic medium is a compressed gas contained in a chamber.

Further compression of the gas results from the action of a piston, which follows the movement of a vehicle wheel.

The spring rate of steel springs is, in general, constant. Thus the damping characteristic of most prior-art vehicle suspension systems using such a spring is linear or nearly linear, which is their major disadvantage. Some of steel springs, e.g. coil springs, can be made progressive, however damping characteristic of vehicle suspension using such springs cannot be freely shaped and remains remarkably inferior to that of the air spring.

Some unconventional vehicle suspension systems providing non-linear damping characteristic and means for adjusting it are known from prior art. For example the International Publication WO-A-96 11815 of the International Application PCT/CA 95/00570 discloses a suspension system, in which the suspension arm rotates roller carriers, the rollers contained therein follows cam surfaces, which in turn force a spring supports to move axially and to compress the spring. The US patent No. 3,157,394 granted to Mr. O. K. Kelley in 1964 provides another example of suspension with a cam mechanism, a number of in turn actuated Belleville springs and non-linear non-differentiable characteristic. However non-linearity of damping characteristic of these suspensions is achieved by engaging springs through a cam mechanism; and means for adjusting the characteristic are shape of the cam, its position relative other elements of the suspension mechanism and nuts to regulate the initial length of the spring. Consequently, these suspensions are exceedingly complicated, of questionable durability and reliability, unable to cope with large loads, and means for adjusting damping characteristic of them are completely unsatisfactory.

A vehicle suspension, according to the present invention, is a purely mechanical device. Non-linearity of its damping characteristic and means for adjusting it to specific requirements is derived directly from the kinetic of the four bar mechanism. It contains no foreign ad hoc incorporated parts e.g. cams and features a compact and robust structure. In fact the structure of the mechanism of the suspension according to the present invention is the strongest possible as its moving parts occupy the whole internal space of its body. Thus it can cope with large loads and the capacity/weight ratio would be better than that of all kinds of known suspensions. It uses only standard springs, while it provides a damping characteristic, which betters that of hydro-pneumatic suspensions. Moreover the construction of the suspension, according to the invention, enables its characteristic to be freely chosen through the choice of the geometric parameters of the mechanisms comprised therein.

The manufacturing technology of the suspension according to the invention is simple and inexpensive. Moreover, the suspension provides the possibility of the relative position between elements connecting the suspension unit with vehicle wheels and a spring to be freely adjusted.

The invention solves the problem of constructing a vehicle suspension of non-linear characteristic using springs of linear characteristic. By non-linear characteristic is meant non-linear and differentiable dependence of suspension stiffness on vehicle axle flex.

The object of the invention is to provide a new type of vehicle suspension system destined for new vehicles, particularly for road and off-road ones, which also can be assembled in existing vehicles during overhauls, e.g. in tanks, and which improves substantially the shock absorption within the whole range of dynamical loads and vehicle weight variations.

The essence of the vehicle suspension system, according to the present invention, is that it comprises at least one flat or spatial four-link mechanism, three kinematic pairs of which are rotational ones, while the fourth one is either a rotational or a sliding one; and the two links of said mechanism are made in the form of eccentric and one link is made in the form of eccentric or slider, wherein one link of said mechanism is coupled with a vehicle wheel, another link of the mechanism is coupled with a spring, and the whole mechanism is fastened to a vehicle frame through yet another link, to obtain a non-linear dependence of deformation of the spring on an axle flex.

A good result is obtained when said suspension system, as four links of its mechanism, comprises a shaft fitted with an eccentric which is coupled rotationally with an intermediate eccentric, the latter being coupled rotationally with a disc, while the shaft and the disc pivot directly in a mechanism body. The body is fastened to a vehicle frame. The shaft, in turn, is coupled rigidly with a vehicle wheel arm, and the disc is coupled with one end of a spring, the other end of which is fastened to the body of the mechanism or directly to the vehicle frame. In this arrangement, the axes of rotation of all the kinematic pairs of the suspension mechanism are parallel to each other.

A good result is also obtained when the suspension system, as its four links, comprises a shaft fitted with an eccentric which is coupled rotationally with an intermediate eccentric, which, in turn, is coupled rotationally with a disc, while the shaft and the disc pivot directly in a mechanism body, the latter being fastened to a vehicle frame. Besides, the disc is coupled rigidly with a vehicle wheel arm, and the shaft is coupled with one end of a spring the other end of which is fastened to the body or directly to the vehicle frame. In this arrangement the axes of rotation of all the kinematic pairs of the suspension mechanism are parallel to each other.

Amended sheet 2.

What I claim is:

1. A vehicle suspension system comprising a spring and at least one flat or spatial four-link mechanism (K, M, W, D), at least three kinematic pairs of which are rotational ones, wherein one of the links of said mechanism is coupled with a vehicle wheel, another of said links is coupled with a spring (S), and the whole mechanism is fastened to a vehicle frame through yet another link of said mechanism, to obtain non-linear dependence of deformation of the spring on the vehicle wheel flex, characterized in that, three of said links are made in the form of an eccentric, whereby said four-link mechanism (K, M., W, D) comprises a shaft (W) fitted with an eccentric (MW), the latter being coupled rotationally with an intermediate eccentric (M), the latter being coupled rotationally with a disc (D), wherein the shaft (W) and the disc (D) pivot directly in a body (K).

2. A vehicle suspension system according to claim 1, characterized in that the axes of rotation of all the kinematic pairs of said suspension mechanism are parallel to each other.

3. A vehicle suspension system according to claim 1, characterized in that the axes of rotation of all the kinematic pairs of said suspension mechanism intersect at a precisely one point P, to obtain a required position of the spring relative to the vehicle wheel.

4. A vehicle suspension system according to claim 2 or claim 3, characterized by said body (K) being fastened to a vehicle frame, and said shaft (W) being coupled rigidly with a wheel arm, and wherein the disc (D) is coupled with one end of the spring (S) the other end of which is fixed to the body (K) or directly to the vehicle frame.

5. A vehicle suspension system according to claim 2 or claim 3, characterized by said body (K) being fastened to a vehicle frame, and said disc (D) being coupled rigidly with a wheel arm, and said shaft (W) being coupled with one end of a spring (S) the other end of which is fixed to the body (K) or directly to the vehicle frame.

6. A vehicle suspension system according to claim 2 or claim 3, characterized by said shaft (W) being fastened to a vehicle frame through the flange (Z), said intermediate eccentric (M) being coupled rigidly with a vehicle wheel arm (H), and said body (K) being coupled rigidly with one end of a spring (S) the other end of which is fixed to the shaft (W) or directly to the vehicle frame.

7. A vehicle suspension system according to claim 2 or claim 3, characterized by said body (K) being fastened to a vehicle frame, said shaft (W) being coupled rigidly with a vehicle wheel arm, and the intermediate eccentric (M) being coupled with one end of an U-shaped torsion bar the other end of which is fixed to the intermediate eccentric of an analogous mechanism of a suspension of the other wheel.

8. A vehicle suspension system comprising a spring and a least one flat or spatial four-link mechanism (K, M, W, D), three kinematic pairs of which are rotational ones and one of the links being made in the form of a slider such that the fourth kinematic pair is a sliding one, wherein one of the links of said mechanism is coupled with a vehicle wheel, another of said links is coupled with a spring (S), and the whole mechanism is fastened to a vehicle frame through yet another link of said mechanism, to obtain non-linear dependence of deformation of the spring on the vehicle wheel flex, characterized in that, two of said links are made in the form of an eccentric, whereby said four-link mechanism comprises a shaft (W) fitted with an eccentric (MW), the latter being coupled rotationally with an intermediate eccentric (M), the latter being coupled rotationally with a slider (D), wherein the shaft (W) pivots directly in a body (K) and the slider is slidingly fitted in the body (K).

9. A vehicle suspension system according to claim 8, characterized by a shaft (W) fitted with three eccentrics (MW1), (MW2) and (MW3), the latter being coupled rotationally with corresponding intermediate eccentrics (M1), (M2), and (M3), the latter being coupled rotationally with corresponding (D1), (D2) and (D3), wherein the sliders (D1), (D2) and (D3) are slidingly fitted in the body (K), said body (K) being fastened to a vehicle frame, the slider (D2) being coupled with a vehicle axle and the sliders (D1) and (D2) being coupled with a spring, which, in turn, is fastened to the vehicle frame.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION** see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/PL 00/ 00030	19/04/2000	12/07/1999
Applicant		
OLEDZKI, Wieslaw, Julian		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

   [ ] contained in the international application in written form.

   [ ] filed together with the international application in computer readable form.

   [ ] furnished subsequently to this Authority in written form.

   [ ] furnished subsequently to this Authority in computer readble form.

   [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 1

   [X] as suggested by the applicant.

   [ ] because the applicant failed to suggest a figure.

   [ ] because this figure better characterizes the invention.

   [ ] None of the figures.

INTERNATIONAL SEARCH REPORT

Inter[redacted]nal Application No
PC[redacted] 00/00030

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B60G17/02 B60G11/00 B60G21/04 B60G21/055

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B60G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 96 11815 A (HOLT LAURENCE J) 25 April 1996 (1996-04-25) figures 8-19	1
A	US 1 991 911 A (RILEY, P.) 19 February 1935 (1935-02-19) figures 1,8	1
A	US 3 157 394 A (KELLEY, O.K.) 17 November 1964 (1964-11-17) figures 1-3,7,8	1
A	US 3 460 852 A (BENSON RICHARD J) 12 August 1969 (1969-08-12) figures	1

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 August 2000	04/09/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Tsitsilonis, L

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Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Inter[redacted]nal Application No
PC[redacted]L 00/00030

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	WO 94 11650 A (NAI NEWAY INC) 26 May 1994 (1994-05-26) figures -----	

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PC[redacted] 00/00030

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9611815 A	25-04-1996	CA 2117945 A	13-04-1996
		AU 3602495 A	06-05-1996
		BR 9506409 A	09-09-1997
		CN 1136793 A	27-11-1996
		EP 0730534 A	11-09-1996
		JP 9507451 T	29-07-1997
		US 5839742 A	24-11-1998
US 1991911 A	19-02-1935	DE 625467 C	
		FR 773542 A	20-11-1934
		GB 420433 A	
US 3157394 A	17-11-1964	NONE	
US 3460852 A	12-08-1969	NONE	
WO 9411650 A	26-05-1994	US 5375819 A	27-12-1994
		AU 5349294 A	08-06-1994
		EP 0667938 A	23-08-1995
		US 5682922 A	04-11-1997
		US 5787932 A	04-08-1998

Vehicle suspension system, particularly for road and off-road vehicles

The present invention relates to a vehicle suspension system, particularly for road and off-road vehicles, such as trucks, buses and military vehicles, including tanks, and first of all for those vehicles whose weight and dynamical loads vary within a broad range during the operating process.

The main function of vehicle suspension is to reduce vibrations transferred to a vehicle body by vehicle wheels. The suspension is a set of elements connecting the vehicle wheels with the vehicle frame or body. Suspensions of automotive vehicles are fitted with steel springs such as leaf springs, coil springs, torsion bars, as well as solid rubber elements and pneumatic springs and hydro-pneumatic elements.

Leaf springs are made of elastic steel flat bars. The leaf spring, supported in the middle and loaded on both ends, is subject to deformation and simultaneously works against the forces of elasticity.

Coil springs are made of steel spring wire. They are lighter and easier to assemble than leaf springs but unable to transfer side forces, hence additional elements are necessary to hold the vehicle axle.

Torsion bars are steel springs made in the form of rod, tube or flat bar pack, one end of which is anchored e.g. in a vehicle frame while the other one is twisted by an arm of a vehicle wheel.

Pneumatic springs are built in the form of two or three-fold bellow manufactured of synthetic rubber reinforced with cord plait and tightened in metallic holders. Pneumatic springs work utilizing pressure of compressed air contained therein. They are used in buses and trucks as well as in off road vehicles. There are also hydro-pneumatic suspensions, in which the elastic medium is a compressed gas contained in a chamber.

Further compression of the gas results from the action of a piston, which follows the movement of a vehicle wheel.

A vehicle suspension, according to the present invention, is a purely mechanical device. It features a compact and robust structure and it uses only standard springs, while it provides a characteristic, which betters that of hydro-pneumatic suspensions. Moreover, the construction of the suspension, according to the invention, enables its characteristic to be freely chosen through the choice of the geometric parameters of the mechanisms comprised therein.

The manufacturing technology of the suspension according to the invention is simple and inexpensive. Moreover, the suspension provides the possibility of the relative position between elements connecting the suspension unit with vehicle wheels and a spring to be freely adjusted.

The invention solves the problem of constructing a vehicle suspension of non-linear characteristic using springs of linear characteristic. By non-linear characteristic is meant non-linear and differentiable dependence of suspension stiffness on vehicle axle flex.

The object of the invention is to provide a new type of vehicle suspension system destined for new vehicles, particularly for road and off-road ones, which also can be assembled in existing vehicles during overhauls, e.g. in tanks, and which improves substantially the shock absorption within the whole range of dynamical loads and vehicle weight variations.

The essence of the vehicle suspension system, according to the present invention, is that it comprises at least one flat or spatial four-link mechanism, three kinematic pairs of which are rotational ones, while the fourth one is either a rotational or a sliding one, and the two links of said mechanism are made in the form of eccentric and one link is made in the form of eccentric or slider, wherein one link of said mechanism is coupled with a vehicle wheel, another link of the mechanism is coupled with a spring, and the whole mechanism is fastened to a vehicle frame through yet another link, to obtain a non-linear dependence of deformation of the spring on an axle flex.

A good result is obtained when said suspension system, as four links of its mechanism, comprises a shaft fitted with an eccentric which is coupled rotationally with an intermediate eccentric, the latter being coupled rotationally with a disc, while the shaft and the disc pivot directly in a mechanism body. The body is fastened to a vehicle frame. The shaft, in turn, is coupled rigidly with a vehicle wheel arm, and the disc is coupled with one end of a spring, the other end of which is fastened to the body of the mechanism or directly to the vehicle frame.

In this arrangement, the axes of rotation of all the kinematic pairs of the suspension mechanism are parallel to each other.

A good result is also obtained when the suspension system, as its four links, comprises a shaft fitted with an eccentric which is coupled rotationally with an intermediate eccentric which, in turn, is coupled rotationally with a disc, while the shaft and the disc pivot directly in a mechanism body, the latter being fastened to a vehicle frame. Besides, the disc is coupled rigidly with a vehicle wheel arm, and the shaft is coupled with one end of a spring the other end of which is fastened to the body or directly to the vehicle frame. In this arrangement the axes of rotation of all the kinematic pairs of the suspension mechanism are parallel to each other.

A good result is also obtained when the suspension system comprises a shaft fitted with a flange and an eccentric, the latter being coupled rotationally with an intermediate eccentric which, in turn, is coupled rotationally with a disc, while the shaft and the disc pivot directly in a mechanism body. The shaft is fastened to a vehicle frame with the help of the flange, while the intermediate eccentric is coupled rigidly with a vehicle wheel arm, and the body is coupled rigidly with one end of a spring the other end of which is fastened to the shaft or directly to the vehicle frame.

In this arrangement the axes of rotation of all the kinematic pairs of the suspension mechanism are parallel to each other.

A good result is also obtained when the suspension system comprises two flat four-link mechanisms and a steel spring in the form of U-shaped torsion bar, wherein each mechanism, as its four links, comprises a shaft fitted with an eccentric which is coupled rotationally with an intermediate eccentric, the latter in turn being coupled rotationally with a disc, whereas the shaft and the disc pivot directly in a mechanism body.

The body of each mechanism is fastened to a vehicle frame, and the shaft is coupled rigidly with a vehicle wheel arm, while the intermediate eccentric is coupled with one end of the U-shaped torsion bar the other end of which is fastened to the intermediate eccentric of the analogous mechanism of the suspension of the other wheel.

In this arrangement the axes of rotation of all the kinematic pairs of each suspension mechanism are parallel to each other.

A good result is also obtained when the suspension system, as four links of its mechanism, comprises a shaft fitted with an eccentric which is coupled rotationally with an intermediate eccentric, the latter in turn being coupled rotationally with a disc, whereas the shaft and the disc pivot directly in a mechanism body. The body is fastened to a vehicle frame and the shaft is coupled rigidly with a vehicle wheel arm, while the disc is coupled with one end of a spring the other end of which is fastened to the mechanism body or directly to the vehicle frame.

The suspension is in accordance with the invention provided that the axes of rotation of all the kinematic pairs of the suspension mechanism intersect at a precisely one point P.

A good result is also obtained when the suspension system, as four links of its mechanism, comprises a shaft fitted with an eccentric which is coupled rotationally with an intermediate eccentric which, in turn, is coupled rotationally with a disc. The shaft and the disc pivot directly in a mechanism body, which is fastened to a vehicle frame.

Besides, the disc is coupled rigidly with a vehicle wheel arm, and the shaft is coupled with one end of a spring the other one of which is fastened to the mechanism body or directly to the vehicle frame.

The suspension is in accordance with the invention provided the axes of rotation of all the kinematic pairs of said suspension mechanism intersect at a precisely one point P.

A good result is also obtained when the suspension system, according to the invention, comprises a shaft fitted with a flange and an eccentric, which is coupled rotationally with an intermediate eccentric, which in turn is coupled rotationally with a disc. The shaft is fastened to a vehicle frame with the help of the flange whereas the intermediate eccentric is coupled rigidly with a vehicle wheel arm. The mechanism's body is coupled rigidly with one end of a spring the other end of which is fastened to the shaft or directly to the vehicle frame.

The suspension is in accordance with the invention provided the axes of rotation of all the kinematic pairs of said suspension mechanism intersect at a precisely one point P.

A good result is also obtained when the suspension system, according to the invention, comprises two four–link spatial mechanisms and a spring in the form of U–shaped torsion bar, whereas each mechanism, as its four links, comprises a shaft fitted with an eccentric which is coupled rotationally with an intermediate eccentric, the latter, in turn, is coupled rotationally with a disc, whereas the shaft and the disc pivot directly in a body. Additionally, the body of each mechanism is fastened to a vehicle frame, and the shaft is coupled with a vehicle wheel arm, while the intermediate eccentric is coupled with one end of the U–shaped torsion bar the other end of which is fastened to the intermediate eccentric of the analogous mechanism of the suspension of the other wheel.

The suspension is in accordance with the invention provided that the axes of rotation of all the kinematic pairs of each of the suspension mechanisms intersect at a precisely one point P.

A good result is also obtained when the suspension system, according to the invention, comprises a shaft fitted with three eccentrics which are coupled rotationally with corresponding intermediate eccentrics which, in turn, are coupled rotationally with corresponding sliders, whereas the shaft pivots directly in a body and the sliders are sliding fitted in the mechanism body, whereas one of the sliders is coupled with a vehicle axle while the two others are coupled with a spring, the latter being fastened to a vehicle frame. The body is fastened to the vehicle frame.

The object of the invention is shown in the accompanying drawings, whereFig. 1 shows a vehicle suspension system provided with a torsion bar, intended for fastening to a vehicle frame

with the help of a mechanism body, and the suspension mechanism shaft coupled with a vehicle wheel arm; Fig. 2 shows a vehicle suspension system provided with a torsion bar and a disc coupled with a wheel arm, which is fit for fastening to a vehicle body with the help of a mechanism body; Fig. 3 shows a vehicle suspension system provided with a coil spring and an intermediate eccentric coupled with a vehicle wheel arm, which is fit for fastening to a vehicle body through the shaft equipped with a flange;

Fig. 4 shows a vehicle suspension system equipped with a U-shaped torsion bar coupling two suspension mechanisms with the help of their intermediate eccentrics; Fig. 5 shows a vehicle suspension system in which the axes of rotation and the axes of symmetry of all the suspension mechanism links intersect at a precisely one point P; Fig. 6 shows a vehicle suspension system of the Mc Pherson type; Fig. 7 shows a vehicle suspension system equipped with a leaf spring; Fig. 8 provides an example of a suspension answer force F as a function of a vehicle wheel flex x.

Example 1

The suspension unit comprises a shaft (W) fitted with an eccentric bore chamber (MW). In the eccentric bore chamber (MW) of the shaft (W) pivots a pivot (C) of an intermediate eccentric (M), the other end of which pivots inside of the eccentric bore chamber of a disc (D). The shaft (W) and the disc (D) pivot directly in a body (K). An arm (H) is fastened to the pivot of the shaft (W). One end of a torsion bar (S) is coupled rigidly with the disc (D), and the other one is anchored in a vehicle frame. The entire suspension unit is fastened to the vehicle frame with the help of a flange (Z) at the body (K).

In this arrangement, the axis OW of rotation of the shaft (W) relative to the body (K), the axis OD of rotation of the disc (D) relative to the body (K), the symmetry axis OC of the eccentric (MW) at the shaft (W) and the overlapping axis of rotation of the shaft (W) relative to the intermediate eccentric (M), and the symmetry axis OM of the intermediate eccentric (M), and the overlapping axis of rotation of the intermediate eccentric (M) relative to the disc (D) are all parallel to each other.

Owing to said arrangement, the suspension features a strongly progressive characteristic, much better than that of the hydro-pneumatic ones. Its characteristic is differentiable in contradistinction to other progressive suspensions of jump characteristic fitted with a few in turns actuating steel springs.

The suspension gives the possibility to choose freely the suspension characteristics, including its progressiveness, through the selection of geometric parameters of its mechanism,

what is an additional advantage over hydro-pneumatic suspension whose characteristic is determined by the gas being used. The suspension features a combination of small deformations of the spring with large wheel flex, which lengthens spring's life.

Example 2

The suspension unit comprises a shaft (W) fitted with an eccentric (MW), said eccentric (MW) being pivoted in an eccentric bore chamber of an intermediate eccentric (M), whereas the eccentric (M) pivots inside of an eccentric bore chamber of a disc (D). The shaft and the disc pivot in a body (K).

A torsion bar (S) is fastened to the shaft (W), and an arm (H) is coupled with the disc (D). The whole suspension unit is fixed to a vehicle frame with the help of a flange (Z) at the body (K).

In this arrangement, the axis OW of rotation of the shaft (W) relative to the body (K), the axis OD of rotation of the disc (D) relative to the body (K), the symmetry axis OC of the eccentric (MW) at the shaft (W) and the overlapping axis of rotation of the shaft (W) relative to the intermediate eccentric (M), and the symmetry axis OM of the intermediate eccentric (M) and the overlapping axis of rotation of the intermediate eccentric (M) relative to the disc (D) are all parallel to each other.

The suspension features a very strongly progressive characteristic, since to a relatively small vehicle wheel flex there corespondes a relatively large angle of rotation of the shaft (W), and hence a large torsion of the torsion bar, in contradistinction to the suspension described in Example 1. During overhauls, the suspension may be assembled in existing vehicles, e.g. in tanks.

Example 3

The suspension system comprises a shaft (W) fitted with an eccentric (MW), wherein the eccentric (MW) pivots in an eccentric bore chamber of an intermediate eccentric (M), and the eccentric (M) pivots inside of an eccentric bore chamber of the disc (D). The disc (D) pivots directly in a body (K) and the body (K) is coupled rotationally with the main pivot of the shaft (W). An arm (H) is fastened to a pivot (C) of the intermediate eccentric (M). The body (K) is fitted with a bracket (WS) on which the coil spring (S) is being supported, the other end of which rests on a vehicle frame. The whole suspension unit is fastened to a vehicle body with the help of a flange (Z) at the shaft (W).

In this arrangement the axis OW of rotation of the shaft (W) relative to the body (K), the axis OD of rotation of the disc (D) relative to the body (K), the symmetry axis OC of the

eccentric (MW) at the shaft (W) and the overlapping axis of rotation of the shaft (W) relative to the intermediate eccentric (M), and the symmetry axis OM of the intermediate eccentric (M) and the overlapping axis of rotation of the intermediate eccentric (M) relative to the disc (D) must be parallel to each other.

The described suspension mounting to the vehicle frame makes it easier to use a coil spring, which is the most widespread kind of steel spring. The suspension may be assembled in existing vehicles, e.g. in tanks, during overhauls.

Example 4

An arrangement described in this example is a compound suspension system for two wheels on common axle. It comprises two four-link mechanisms and a spring in the form of U-shaped torsion bar, which works simultaneously as a stabilizer. The torsion bar is coupled rotationally with a vehicle frame through clamping rings (O) at the base of the letter U.

The suspension mechanism, as its four links, comprises a shaft (W) fitted with an eccentric (MW) which is coupled rotationally with an intermediate eccentric (M) which, in turn, is coupled rotationally with a disc (D). The shaft (W) and the disc (D) pivot directly in a body (K). The body (K) of each mechanism is fastened to a vehicle frame, the shaft (W) is coupled rigidly with an arm (H), and the intermediate eccentric (M) is coupled with one end of the U-shaped torsion bar the other end of which is fastened to the intermediate eccentric of the analogous mechanism of the other wheel suspension. In both mechanisms, the axis OW of rotation of the shaft (W) relative to the body (K), the axis OD of rotation of the disc (D) relative to the body (K), the symmetry axis OC of the eccentric (MW) at the shaft (W) and the overlapping axis of rotation of the intermediate eccentric (M) relative to the shaft (W), and the symmetry axis OM of the intermediate eccentric (M) and the overlapping axis of rotation of the intermediate eccentric (M) relative to the disc (D) are all parallel to each other.

Owing to the application of an U-shaped torsion bar both ends of which are coupled with elements of the suspension mechanisms executing both the rotary and the planetary motion, the bar is subject to complex stresses depending on the wheels position. In the case of identical flex of both the wheels, the arms of the U-shaped torsion bar are being twisted and simultaneously slightly expanded.. In the case of various flexes of the wheels, the part of the torsion bar constituting the base of the letter (U) additionally is being twisted. Thus, the torsion bar plays the role of both the main spring for two wheels and the stabilizer.

The suspension, similarly to those described above, features a strongly non-linear characteristic, also for the stabilizer.

Example 5

The suspension system comprises a shaft (W) fitted with an eccentric (MW), whereas the eccentric (MW) pivots inside of an eccentric bore chamber of an intermediate eccentric (M), which in turn pivots inside of an eccentric bore chamber of a disc (D). The shaft (W) and the disc (D) pivot directly in a body (K). An arm (H) is fastened to the shaft (W).
A torsion bar (S) is coupled with the disc (D), and the whole suspension unit is fixed to a vehicle frame with the help of a flange (Z) at the shaft (W).

The axes of rotation of all the kinematic pairs of the mechanism of this unit suspension intersect at a precisely one point P. In particular, the axis of rotation of the shaft (W) and the axis of rotation of the disc (D) (the latter overlapping the symmetry axis of the torsion bar) intersect at an angle A.

This arrangement gives the possibility to choose freely the angle A within the range of 0-90^0, which gives the possibility of a position of the spring relative to the wheel to be conveniently chosen. In particular, in the case the angle A equals 90^0, one obtains a suspension with a trailing arm and a longitudinal torsion bar.

The suspension features a strongly non-linear characteristic, which can be freely shaped through an appropriate choice of the geometric parameters of its mechanism.

Example 6

The Mc Pherson-type suspension system comprises a shaft (W) fitted with an eccentric (MW), an intermediate eccentric (M), a disc (D), and a body (K). The shaft (W) and the disc (D) pivot directly in the body (K), while the intermediate eccentric pivots on the shaft eccentric (MW). A radius arm (H) is fastened to the shaft (W), and a bracket (T) supporting a coil spring (S) is fastened to the disc (D).

The axes of rotation of all the kinematic pairs of the suspension mechanism are parallel to each other.

The suspension has a non-linear progressive characteristic and compact structure, typical for suspensions of the McPherson type.

Example 7

A suspension system fitted with a leaf spring has a shaft (W) fitted with three eccentrics (MW1, MW2, MW3), three intermediate eccentrics (M1, M2, M3), and three sliders (D1, D2, D3), whereas the slider set (D1, D2, D3) and the intermediate eccentrics (M1, M2, M3) mate the shaft eccentrics (MW1, MW2, MW3) respectively. The shaft (W) pivots in a body (K), and the sliders (D1, D2, D3) are sliding fitted in the body (K). The central slider (D2) is coupled with a

vehicle axis, and the leaf spring is fastened to the outer sliders (D1) and (D3). Eccentricity ratios of the eccentrics (MW1) and (MW3) are equal one to the other.

Moreover, the eccentricity ratio of each shaft eccentric (MW1, MW2, MW3) equals the eccentricity ratio of the intermediate eccentric (M1, M2, M3) which it mate.

The shaft eccentrics (MW1) and (MW3) are both rotated by certain angle A relative to the shaft eccentric (MW2). The proper choice of the angle A provides a non-linear characteristic of the suspension of the required progressiveness ratio.

The suspension maintains an important advantage of the leaf spring i.e. its capability to hold alone the vehicle axle.

A common distinctive feature of all the suspension systems described above is a non-linear and differentiable characteristic which provides an extraordinary adaptability of the suspension stiffness to variable static and dynamic loads, thus providing a smooth and stable ride within the whole range of the vehicle loads.

What I claim is:

1. A vehicle suspension system, particularly for road and off-road ones, comprising springs, distinguished for the fact that the suspension system comprises at least one flat or spatial four-link mechanism (K), (M), (W) and (D), three kinematic pairs of which are rotational ones while the fourth one is either a rotational or a sliding one, wherein two links are made in the form of eccentric and one link is made in the form of eccentric or slider, wherein one of the links of said mechanism is coupled with a vehicle wheel, the other one is coupled with a spring (S), and the whole mechanism is fastened to a vehicle frame through yet another link of said mechanism, to obtain non-linear dependence of deformation of the spring on the vehicle wheel flex.

2. A vehicle suspension system according to claim l, distinguished for the fact that the suspension mechanism, as its four links, comprises a shaft (W) fitted with an eccentric (MW), the latter being coupled rotationally with an intermediate eccentric (M), the latter being coupled rotationally with a disc (D), wherein the shaft (W) and the disc (D) pivot directly in a body (K), said body (K) being fastened to a vehicle frame, and said shaft (W) being coupled rigidly with a wheel arm, and wherein the disc (D) is coupled with one end of the spring (S) the other end of which is fixed to the body (K) or directly to the vehicle frame, assuming the axes of rotation of all the kinematic pairs of said suspension mechanism are parallel to each other.

3. A vehicle suspension system according to claim l, distinguished for the fact that the suspension mechanism, as its four links, comprises a shaft (W) fitted with an eccentric (MW), the latter being coupled rotationally with an intermediate eccentric (M), the latter being coupled rotationally with a disc (D), wherein the shaft (W) and the disc (D) pivot directly in a body (K), said disc (D) being coupled rigidly with a wheel arm, and said shaft (W) being coupled with one end of a spring (S) the other end of which is fixed to the body (K) or directly to a vehicle frame, assuming the axes of rotation of all the kinematic pairs of said suspension mechanism are parallel to each other.

4. A vehicle suspension system according to claim 1, distinguished for the fact that the suspension mechanism contains a shaft (W) fitted with a flange (Z) and an eccentric (MW), the latter being coupled rotationally with an intermediate eccentric (M), the latter being coupled rotationally with a disc (D), wherein the shaft (W) and the disc (D) pivot in a body (K), said

shaft (W) being fastened to a vehicle frame through the flange (Z), said intermediate eccentric (M) being coupled rigidly with a vehicle wheel arm (H), and said body (K) being coupled rigidly with one end of a spring (S) the other end of which is fixed to the shaft (W) or directly to the vehicle frame, assuming the axes of rotation of all the kinematic pairs of the suspension mechanism are parallel to each other.

5. A vehicle suspension system according to claim 1, distinguished for the fact that the suspension mechanism, as its four links, comprises a shaft (W) fitted with an eccentric (MW), the latter being coupled rotationally with an intermediate eccentric (M), the latter being coupled rotationally with a disc (D), wherein the shaft (W) and the disc (D) pivot directly in a body (K), said body (K) being fastened to a vehicle frame, said shaft (W) being coupled rigidly with a vehicle wheel arm, and the intermediate eccentric (M) being coupled with one end of an U-shaped torsion bar the other end of which is fixed to the intermediate eccentric of an analogous mechanism of a suspension of the other wheel, assuming the axes of rotation of all the kinematic pairs of the suspension mechanism are parallel to each other.

6. A vehicle suspension system according to claim 1, distinguished for the fact that the suspension mechanism, as its four links, comprises a shaft (W) fitted with an eccentric (MW), the latter being coupled rotationally with and intermediate eccentric (M), the latter being coupled rotationally with a disc (D), wherein the shaft (W) and the disc (D) pivot directly in a body (K), said body (K) being fastened to a vehicle frame, said shaft (W) being coupled rigidly with a wheel arm, and said disc being coupled with one end of a spring (S) the other end of which is fixed to the body (K) or directly to the vehicle frame, assuming the axes of rotation of all the kinematic pairs of said suspension mechanism intersect at a precisely one point P, to obtain a required position of the spring relative to the vehicle wheel.

7. A vehicle suspension system according to claim 1, distinguished for the fact that the suspension mechanism, as its four links, comprises a shaft (W) fitted with an eccentric (MW), the latter being coupled rotationally with an intermediate eccentric (M), the latter being coupled rotationally with a disc (D), wherein the shaft (W) and the disc (D) pivot directly in a body (K), said disc (D) being coupled rigidly with ā wheel arm, said shaft (W) being coupled with one end of a spring (S) the other end of which is fastened to the body (K) or directly to a vehicle frame, assuming the axes of rotation of all the kinematic pairs of said suspension mechanism intersect

at a precisely one point P, to obtain a required position of the spring relative to the vehicle wheel.

8. A vehicle suspension system according to claim 1, distinguished for the fact that the suspension mechanism comprises a shaft (W) fitted with a flange (Z) and an eccentric (MW), the latter being coupled rotationally with an intermediate eccentric (M), the latter being coupled rotationally with a disc (D), wherein the shaft (W) and the disc (D) pivot in a body (K), said shaft (W) being fastened to a vehicle frame with the help of the flange (Z), said intermediate eccentric (M) being coupled rigidly with a wheel arm, and said body (K) being coupled rigidly with one end of a spring (S) the other end of which is fixed to the shaft (W) or directly to the vehicle frame, assuming the axes of rotation of all the kinematic pairs of said suspension mechanism intersect at a precisely one point P, to obtain a required position of the spring relative to the vehicle wheel.

9. A vehicle suspension system according to claim 1, distinguished for the fact that the suspension mechanism, as its four links, comprises a shaft (W) fitted with an eccentric (MW), the latter being coupled rotationally with an intermediate eccentric (M), the latter being coupled rotationally with a disc (D), wherein the shaft (W) and the disc (D) pivot directly in a body (K), said body (K) being fastened to a vehicle frame, said shaft (W) being coupled rigidly with a vehicle wheel arm and said intermediate eccentric (M) being coupled with one end of an U-shaped torsion bar the other end of which is fixed to the intermediate eccentric of an analogous mechanism of a suspension of the other wheel, assuming the axes of rotation of all the kinematic pairs of said suspension mechanism intersect at a precisely one point P, to obtain a required position of the spring relative to the vehicle wheel.

10. A vehicle suspension system according to claim 1, distinguished for the fact that the suspension mechanism comprises a shaft (W) fitted with three eccentrics (MW1), (MW2) and (MW3), the latter being coupled rotationally with corresponding intermediate eccentrics (M1), (M2) and (M3), the latter being coupled rotationally with corresponding sliders (D1), (D2) and (D3), wherein the shaft (W) pivots directly in a body (K), and the sliders (D1), (D2) and (D3) are sliding fitted in the body (K), said body (K) being fastened to a vehicle frame, the slider (D2) being coupled with a vehicle axle and the sliders (D1) and (D3) being coupled with a spring, which, in turn, is fastened to the vehicle frame.

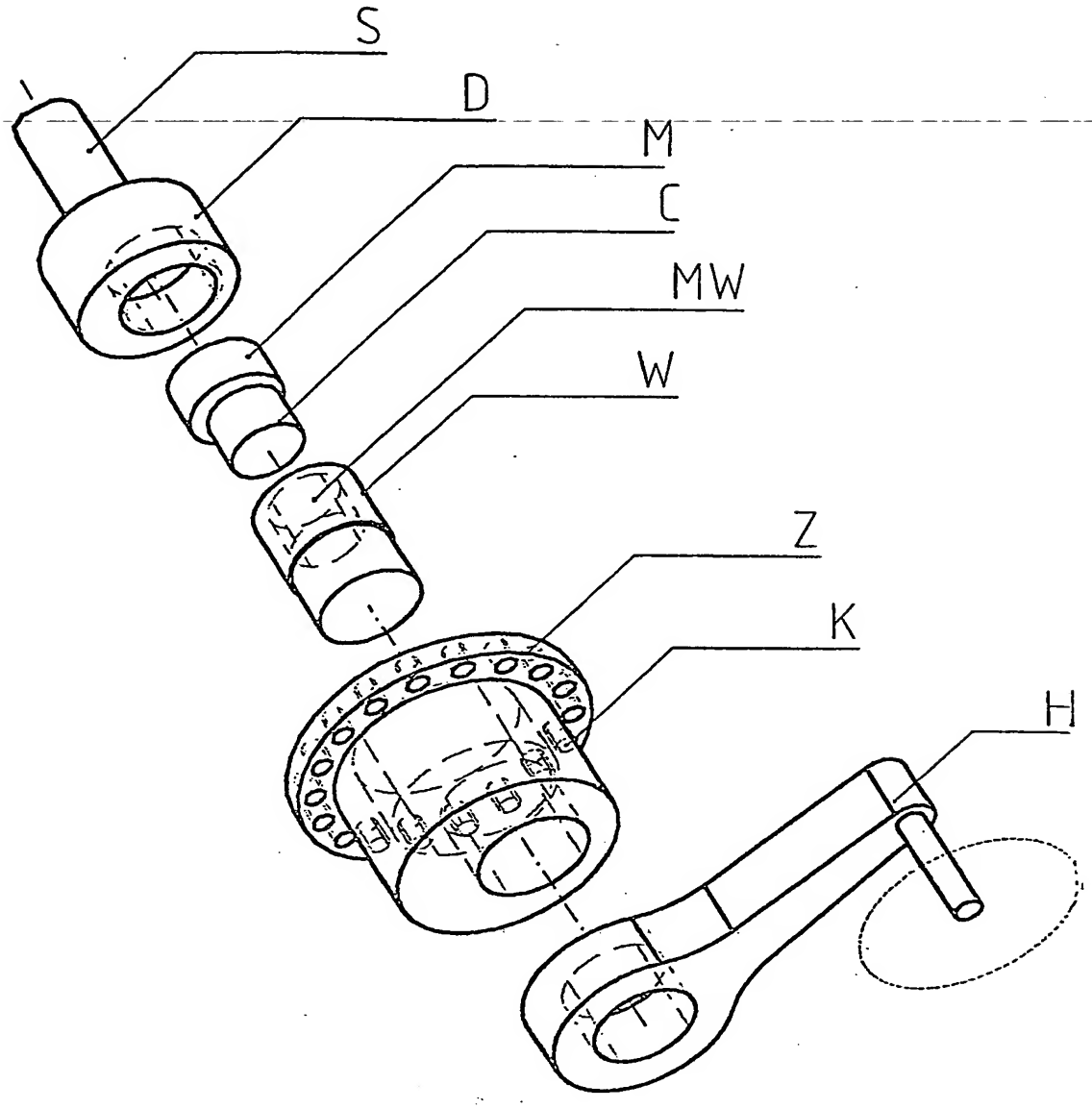

Fig. 1

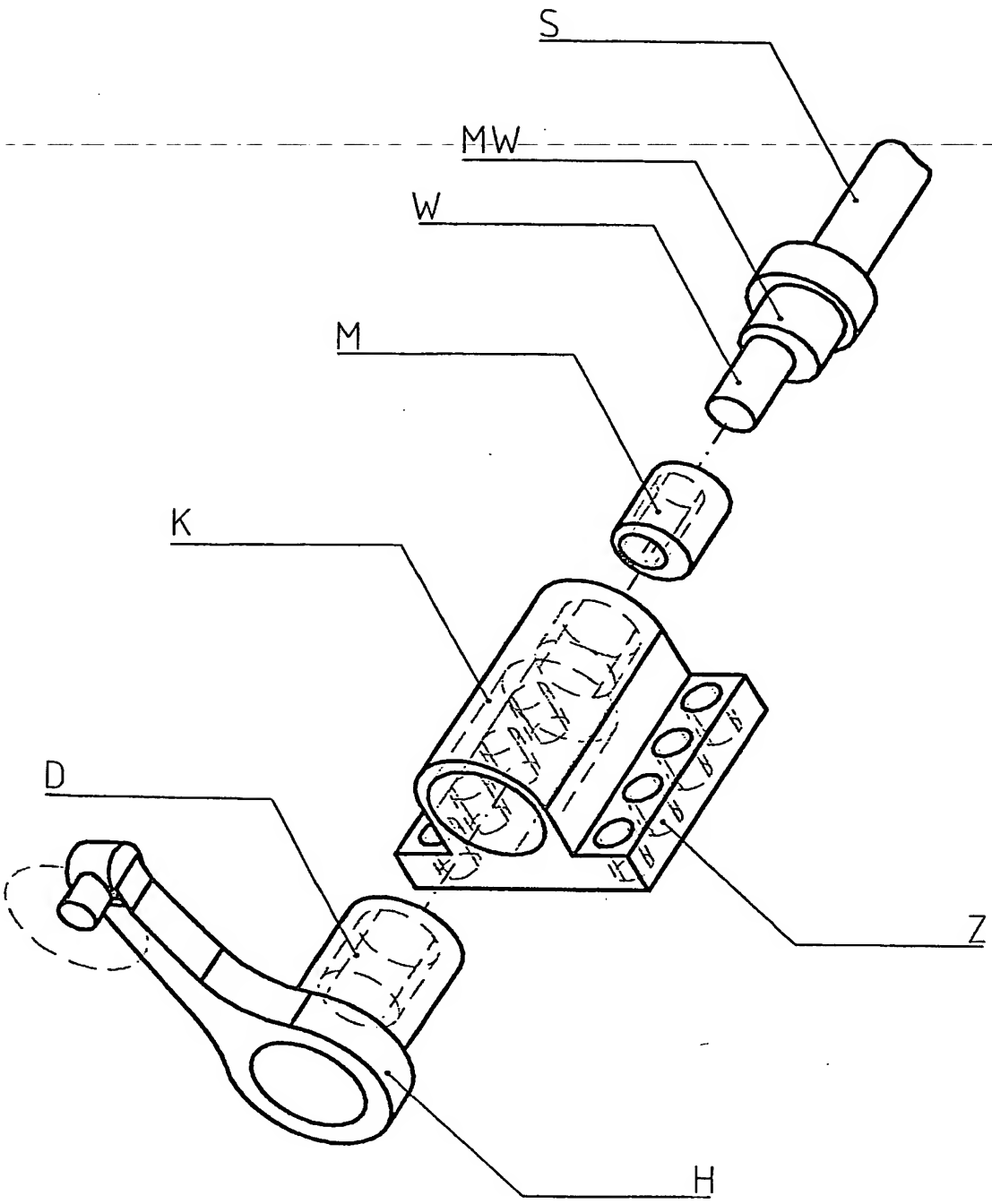

Fig. 2

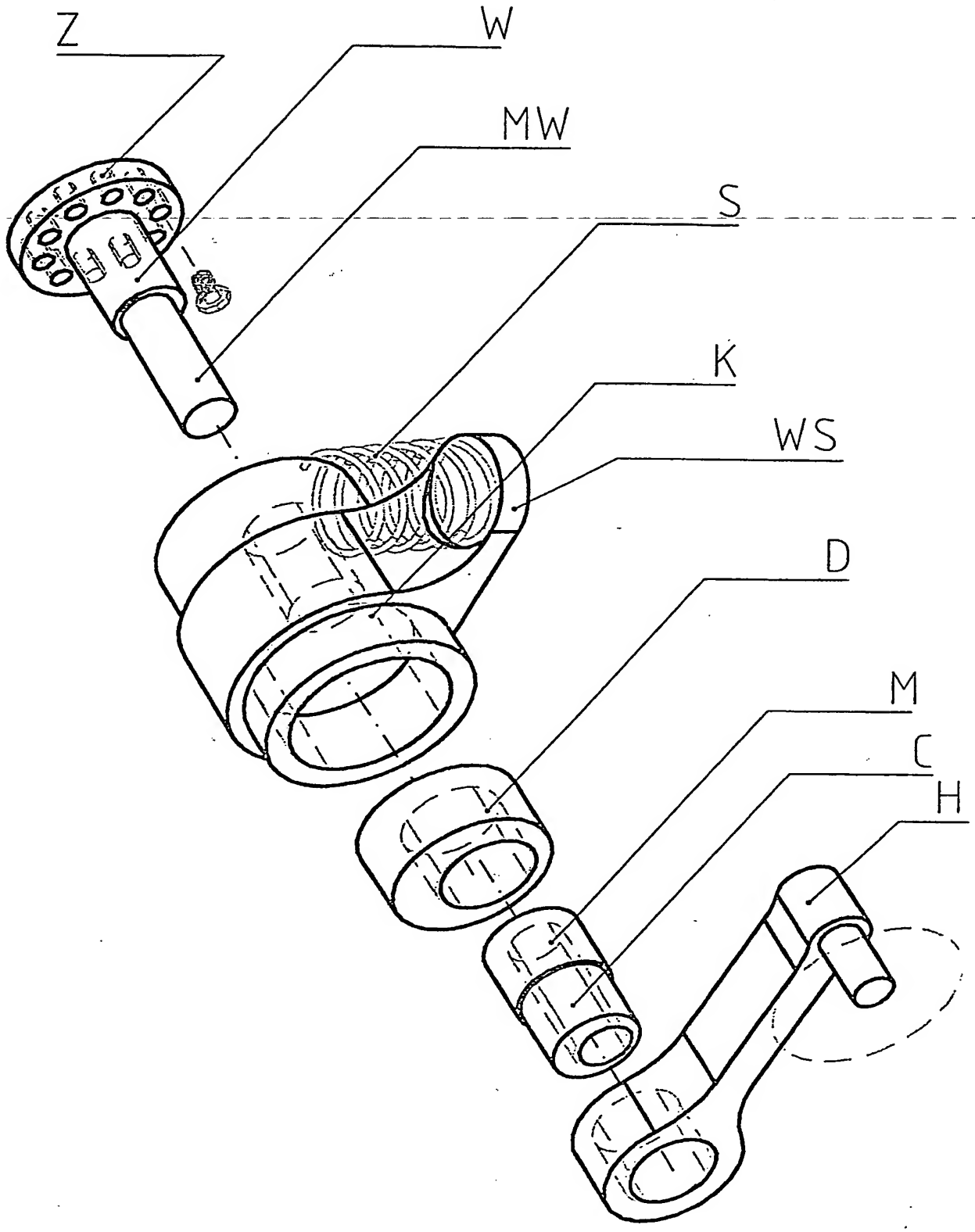

Fig. 3

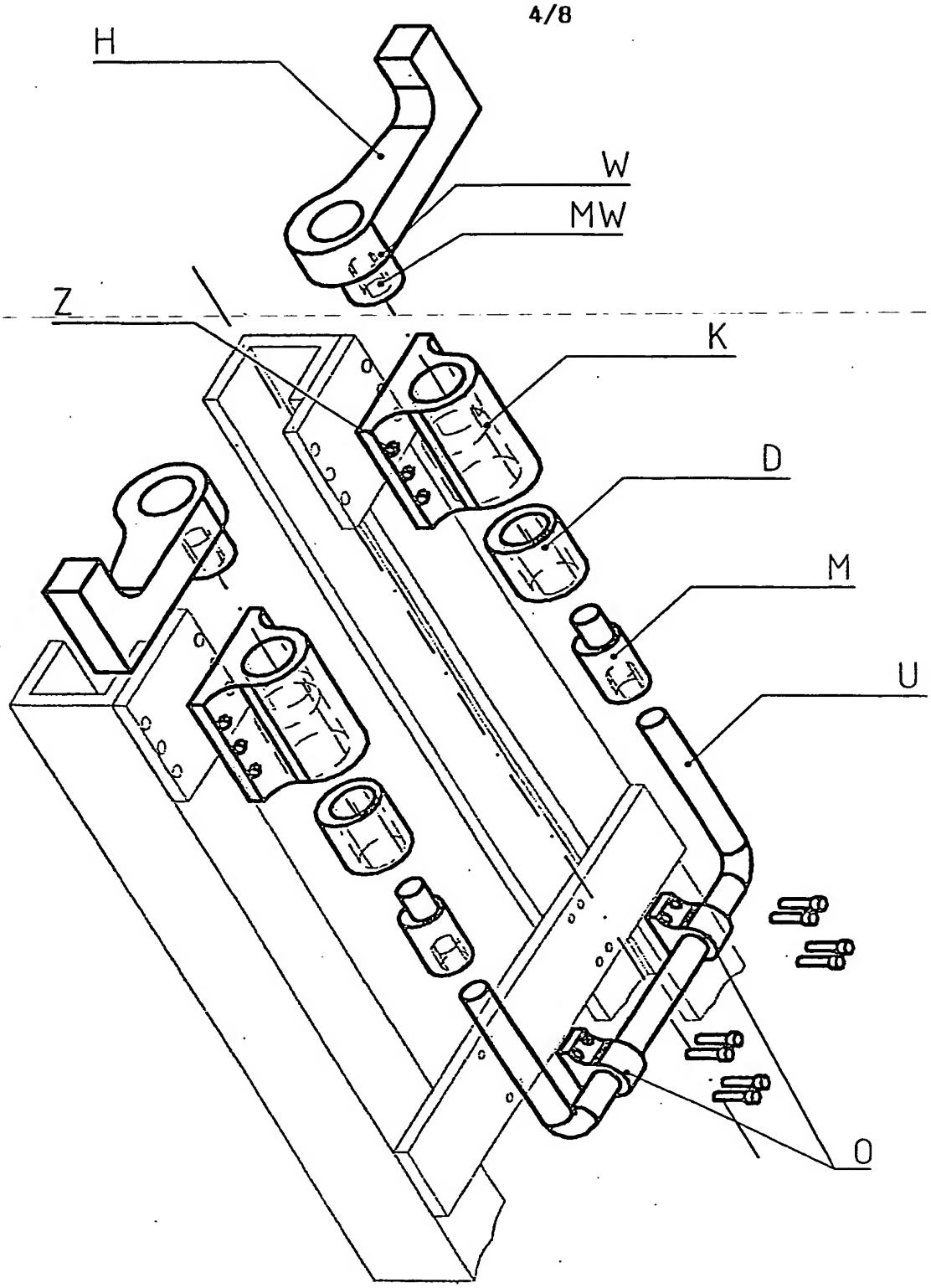

Fig. 4

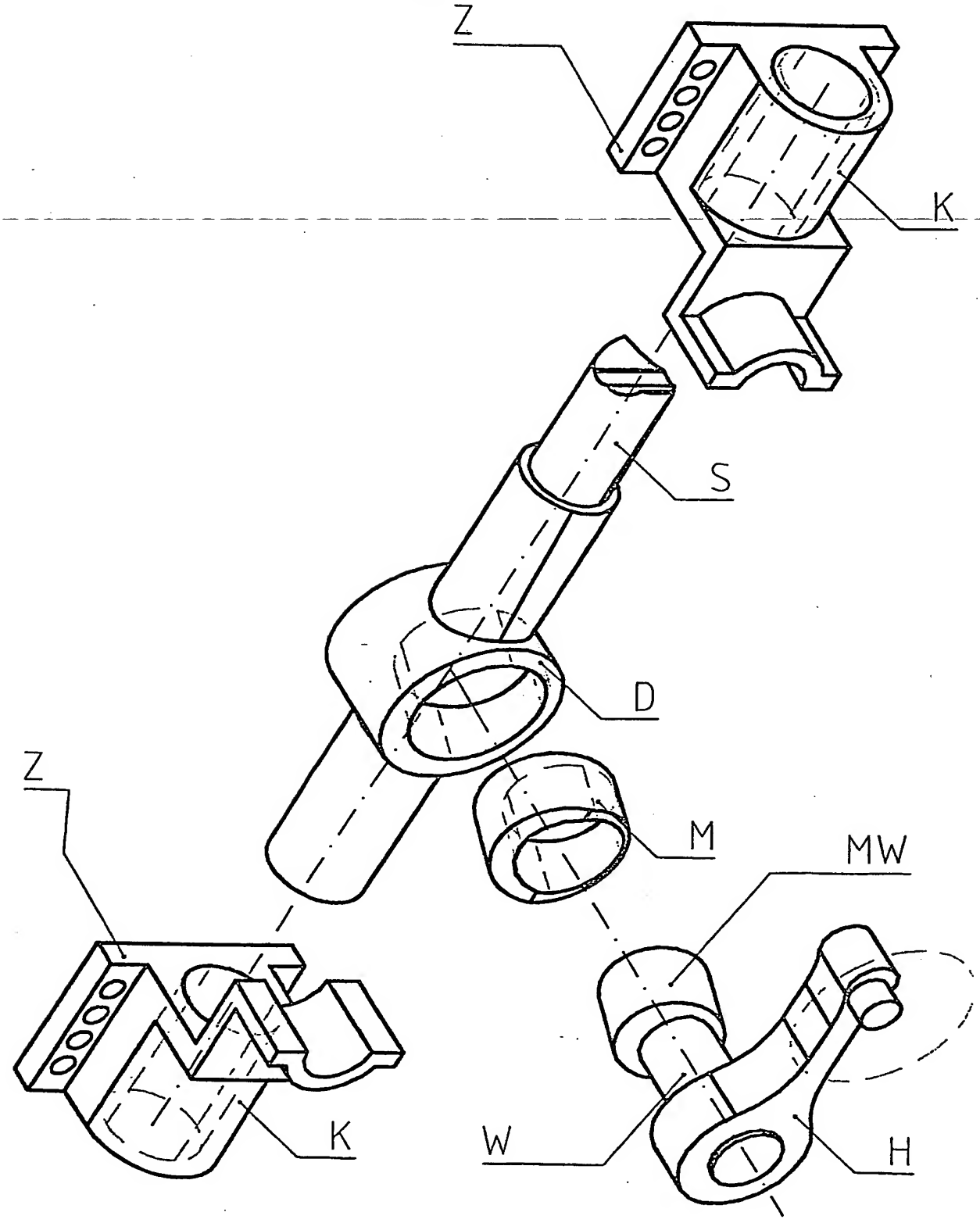

Fig. 5

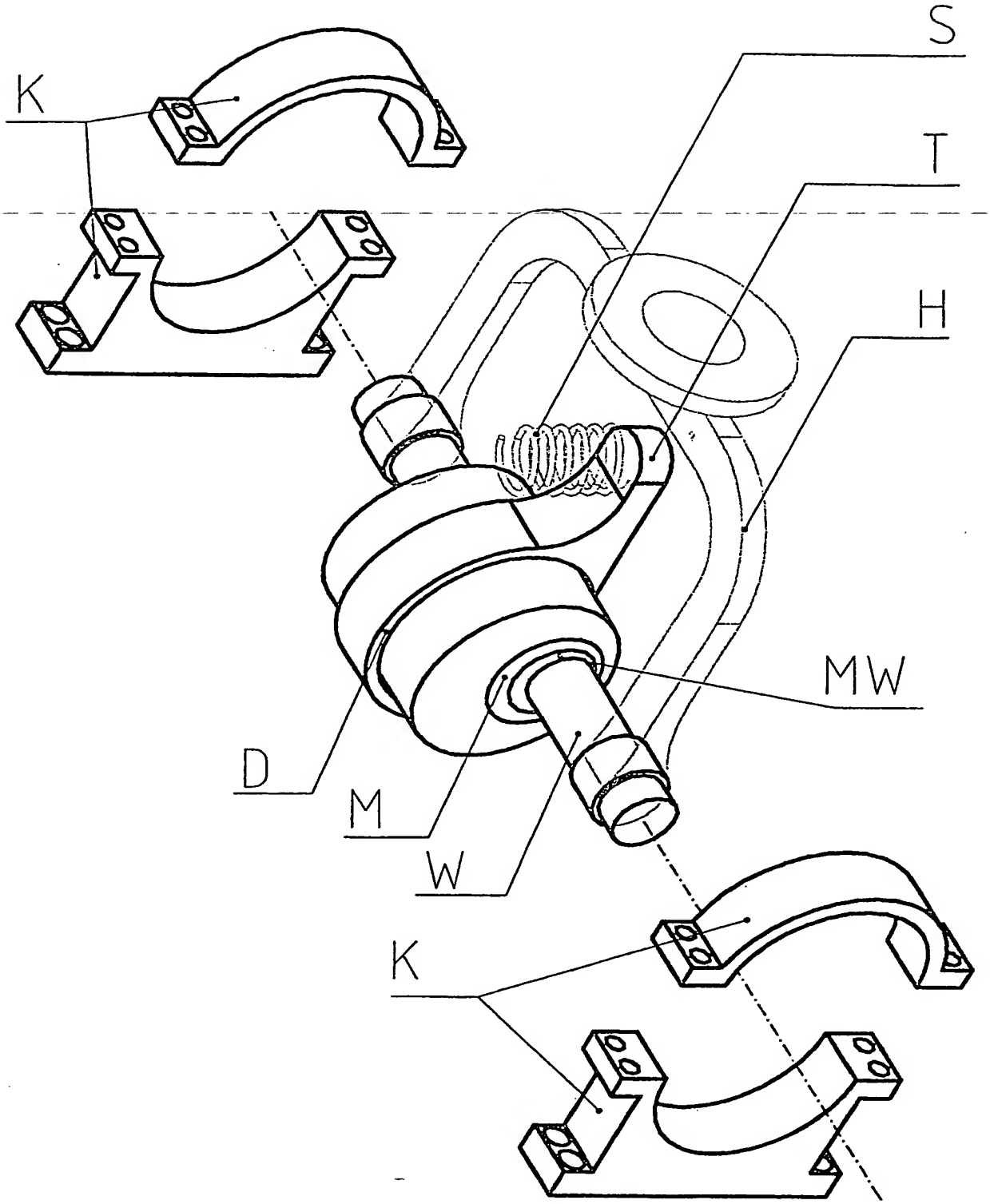

Fig. 6

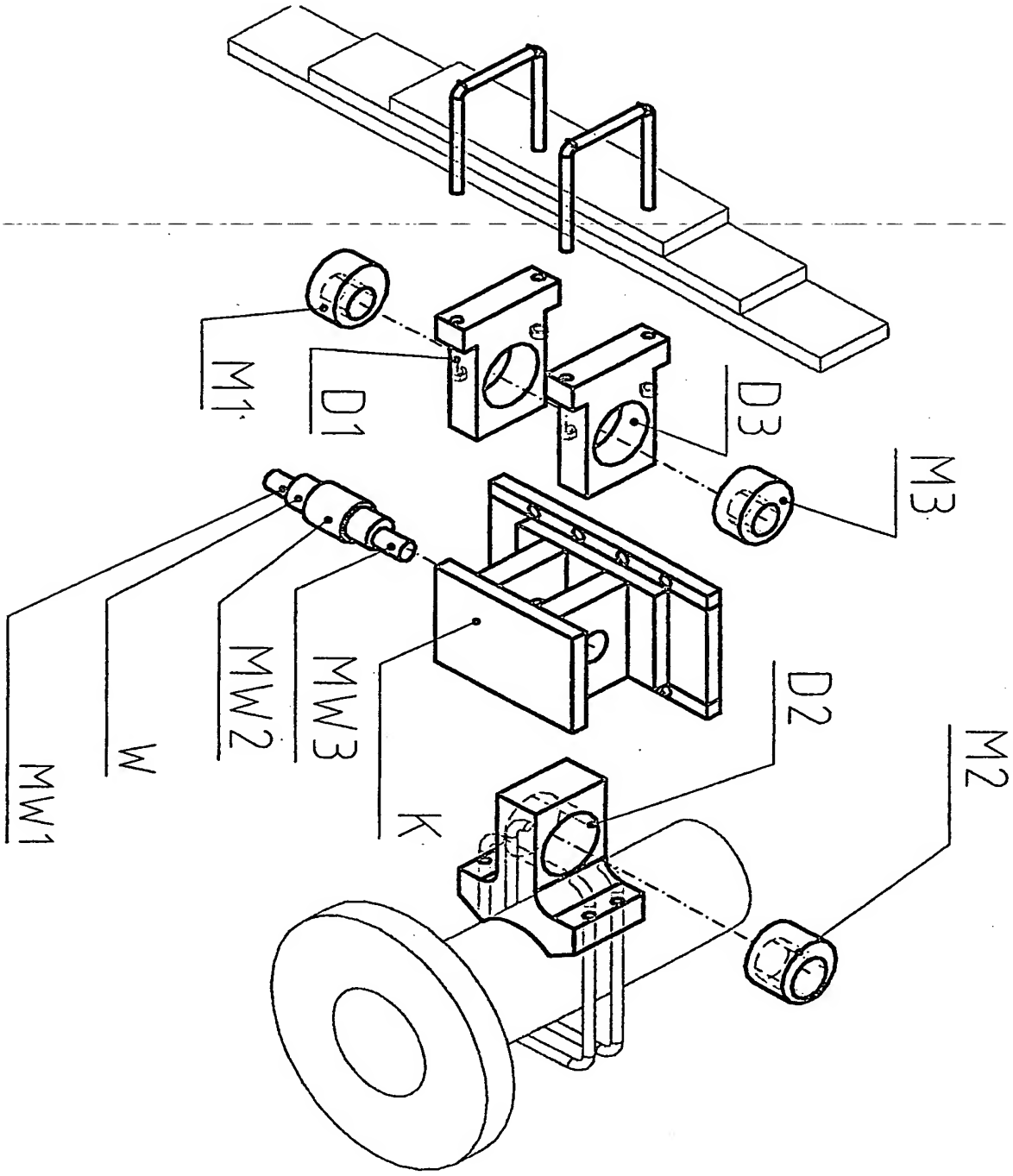

Fig. 7

Fig.8

INTERNATIONAL SEARCH REPORT

In ational Application No
PCT/PL 00/00030

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B60G17/02 B60G11/00 B60G21/04 B60G21/055

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B60G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 96 11815 A (HOLT LAURENCE J) 25 April 1996 (1996-04-25) figures 8-19	1
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
28 August 2000	04/09/2000

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

International Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	WO 94 11650 A (NAI NEWAY INC) 26 May 1994 (1994-05-26) figures	

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